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PHENOMENA ACCOMPANYING RADIO TRANSMISSION

The following is a translation of an address given by His Excellency the Marchese Marconi on the 11th September, 1930, at Trento, on the occasion of the Nineteenth Meeting of the Italian Society for the Progress of Sciences.

THE subject of my brief discourse is: "Phenomena Accompanying Radio Transmissions." A vast subject and one which would demand for handling, however incompletely, far more time than is at my disposal. I shall therefore speak of some only of the many phenomena which accompany radio transmissions and in a somewhat summary and elementary manner.

The numerous successive discoveries of so many new and interesting facts regarding the propagation of electric manifestations and the study of the properties and behaviour of the space across which electric waves can be transmitted have opened up new, vast and fertile fields of useful research which make us always scrutinize more effectively the boundless horizons of conquest as regards the transmission to any distance on our earth and even beyond, of human thought, of the spoken and written word, of sounds and music, of the remote control of power and perhaps also one day of power itself.

About 29 years ago, to be exact, in December, 1901, I discovered the possibility of transmitting electric waves over very long distances, viz., between Europe and America. This discovery was of great importance not only on the practical side but also on the theoretical, because until then almost all physicists believed that the electric waves discovered by Hertz would behave somewhat similarly to luminous waves and that therefore obstacles and the curvature of the earth would inevitably prevent their transmission along the surface of the globe over distances greater than some tens or hundreds of kilometres.

The success of the first Transatlantic radiotelegraph transmissions, confirming my hypotheses, convinced me that very probably there would be no distances in the world across which the transmission of human thought would not be possible by means of electric waves, without the help of artificial conductors.

Refracting Layers in the Upper Atmosphere.

At that time, however, there was lacking a rational theory explaining how these electric radiations could follow the curvature of the earth and reach the most distant countries. Several physicists and mathematicians (among them Raleigh, who in 1903 read a paper regarding the matter to the Royal Society at London), referring

to the results which I had obtained at distances of several thousands of kilometres, demonstrated by calculation that such results could not be explained by the phenomenon of diffraction pure and simple.

Other experiments which I was able to carry out in the Atlantic on the s.s. " Philadelphia " during the month of February, 1902, enabled me to discover another phenomenon of a certain importance, viz., that with waves of about 2,000 metres, then employed by me, the distances of transmission were during the night several times greater than during the day, which led one to suppose that the sunlight limited greatly the range of propagation of the electric waves in space. This, in its turn, indicated either an absorption of the energy of the electric waves caused by sunlight, or a variation in the conditions which permitted the said waves to reach the greatest distances*.

The phenomenon was particularly interesting because trials carried out across rather short distances where the curvature of the earth was not concerned, had never given any sign of variations in the intensity of signals or in their range which could be attributed to the effects of sunlight.

The mathematician Heaviside in England and the physicist Kennelly in America were the first to put forward the hypothesis, at once universally accepted, that at a certain height, at that time not well determined, there must exist a state of ionisation of the atmosphere or a conductive layer constituting a kind of envelope concentric to the surface of our globe, which envelope was capable of reflecting or deflecting the electric waves in such a manner as to compel them to follow the curvature of the earth, impeding their radiation and their loss into infinite space.

The hypothesis of Heaviside was studied and amplified by many scientists, among them Poincaré, Raleigh, Thomson, Macdonald, Sommerfield, Zenneck, Eccles, Appleton, Eckersley, and many others. Loewestein, in a paper published in the " Proceedings of the Institute of Radio Engineers," of New York, in June, 1916, expressed the hypothesis of the existence of three layers which could influence the propagation of electric waves, one at a height of 11 kilometres from the earth and the other two at 75 and 220 kilometres respectively. This hypothesis approximates somewhat to the more modern ideas which not only suppose the existence of manifold zones or layers capable of reflecting or bending the electric waves but also that these zones vary in height and distance from the earth at different hours of the day, with the seasons, and according to their ionisation or composition due, in turn, to the effects of light, to the electric and magnetic activity of the sun and perhaps to other causes still unknown†.

The determination of the height of the reflecting or refracting layers has been and continues to be the object of laborious study on the part of patient investigators, among them Breit, Tuve and Dahl, Kenrick and Jen, who have submitted interesting papers regarding the matter to the Institute of Radio Engineers of New York‡.

The influence of these layers or zones would explain the variations of range and of intensity of the various electric waves according as they are propagated

* Proceedings of the Royal Society (volume 70, page 344, 1902).
† Transactions of the Royal Academy of the Lincei, G. Marconi, Vol. 3, page 78, 1916.
‡ Proceedings of the Institute of Radio Engineers, New York, September, 1928, and April, 1929.

across illuminated or dark zones, or when special conditions of solar activity prevail ; from which it consequently results that the alternation of the seasons and of the light of day with the darkness of night constitutes an element of the very first importance for the determination of the waves most suitable to radio transmissions across given distances.

To-day it is necessary for the investigator into the properties of electric waves and the serious student of the scientific progress of radio communication to keep in touch not only with the work of physicists, mathematicians and electrotechnicians, but also with that of meteorologists and astronomers.

On the other hand it is probable that meteorologists and perhaps also the astronomers may soon in their turn obtain precious information from us, the cultivators of wireless, since the means of research used in the science of radio transmissions is already so powerful and varied as also to enable meteorologists one day to obtain data regarding certain parts of the atmosphere and of space regarding which they possess to-day, very little and very dubious information.

Use of Short Waves for Radio Communication.

The advent of short waves, with their world-wide range of action, has in addition to an incentive, also supplied us with a means of studying such interesting phenomena in a much more complete and exhaustive manner than was at first possible.

Almost everyone now knows that by using the most simple short wave transmitters and receivers, i.e., with waves of a length of from 12 to about 100 metres, it is possible, even with the use of but little electric power, to communicate with Australia and even with the Antipodes when the conditions of the atmosphere or of space are favourable ; while with improved apparatus, employing greater power with the systems of concentration of such power, the so-called beam systems, it is possible to stabilise and maintain almost continuous commercial services at all hours of the day both for radiotelegraph and for radiotelephone transmission, whatever be the distance which separates the transmitting and receiving stations.

This progress obtained with the use of short waves, whose special and valuable properties have been specially studied by me since 1915 and whose practical use I was able to demonstrate and propose as long ago as 1922* have now enabled radio transmissions to overcome the competition of the cables, thus forcing powerful organisations which possess already more than 50 per cent. of the submarine cables of the world to come to an agreement with the international organisation constituted for the use of radiotelegraphy in England.

Modern radiotelegraph and radiotelephone installations have allowed of continually extending, by means of the observation of phenonema of difficult explanation, the studies regarding the transmission of waves ; thus phenomena have been ascertained which are more and more interesting even from the purely scientific side, which study, by reason of the conclusions which might arise from it, is truly fascinating.

The fact that the so-called long waves used for radiotelegraphy did not always follow the shortest route between distant stations was known as early as 1922 by my assistant, Engineer E. Tremellen. His observations were carried out, during a voyage around the world, by means of special transmitting and radiogoniometric

* Proceedings of the Institute of Radio Engineers, Vol. X., No. 4, August, 1922.

apparatus and they proved that in certain cases these waves preferred to follow a long route equal to about three quarters of the circumference of the globe, rather than the direct and shorter route equal to a quarter of the said circumference. These observations were detailed by me in the report which I read before the Institute of Radio Engineers at New York on the 20th June, 1922*.

This phenomenon has already been used practically for some time at modern stations utilising short waves and employed for very long distance transmissions. In fact the English stations of my beam system which carry on public service between England and Australia transmit the waves by the shortest route, of about 18,000 km. across Europe and Asia, during certain hours of the day, while during other hours the transmission is directed through the longest route of about 22,000 km., across the Atlantic, the American continent and the Pacific Ocean. In view of the velocity of electric waves, which is approximately 300 thousand km. per second, the transmission of signals, even by the longest route, does not, of course, involve any appreciable delay, the reception being, for all practical purposes, instantaneous.

Echo and Multiple Signal Phenomena.

Signals which evidently went completely round the earth were remarked by another of my assistants, Engineer Langridge, in July, 1925, while he was listening at Brentwood, England, to the signals transmitted on a wave of 25 metres from the Poldhu station.

An interesting and accurate study of these phenomena was made in 1926 by Quack, who put on record the frequent recurrence (in short wave radio communications) of the perception of a secondary signal or duplicate of the signal immediately after the reception of the principal signal. From measurements carried out by Quack on the basis of the duration of the interval of time between the reception of the principal signal and the reception of the secondary signal, it would appear that the waves in going round the terraqueous globe cover a course of 41,200 km. The fact that this course is somewhat greater than the circumference of the globe would indicate that the electric waves undergo reflections or refractions between a reflecting state (layer) and the earth, or that they describe a maximum circle around the earth situated at a height of 182 km.†.

It is to be noted that the transmissions which take place with the most distant countries, i.e., those near the Antipodes, are effected very often with greater facility than transmissions with countries at intermediate distances, i.e., relatively nearer. This takes place not only as regards the phenomenon of the convergence of the electric waves at the Antipodes but also as regards the fact that by means of the beam system the waves may be directed by one route or the other at will ; if, for example, the conditions for the eastern route are not favourable the waves may be directed by the western route.

The fact of the convergence of the electric waves at the Antipodes, now reliably proved and already brought into common practice, was foreseen by me 25 years ago when in a lecture to the Royal Institution of London I said that radio transmissions to the Antipodes would be possible with the use of relatively small electric power and therefore with an expenditure proportionally less than that which would be necessary for intermediate distances‡.

* Work quoted.
† E. Quack : Zeitschrift uber Hochfrequenztechnik : 28, 117, 1926.
‡ " Recent advances in Wireless Telegraphy," Royal Institution, 3rd March, 1905.

A phenomenon which has roused great interest among students is that of the repetition of signals or electric echoes, a phenomenon which takes place specially with waves of a length lying between 14 and 20 metres. These echoes, however interesting they may be from the point of view of scientific research, are not in fact liked in radiotelegraph stations for the reason that the repetition of signals often tends to confuse or at least to render less clear the reception of messages. Much study has also been given on board the " Elettra " and at other stations both to observing the effects of the so-called echoes and to thinking out suitable devices for suppressing them.

The repetitions of signals whose periods of recurrence is shorter than the time necessary for electric waves to go completely round the earth have been studied by Eckersley*, Van der Pol and many other investigators. But there are repetitions of signals or echoes which would indicate routes rather different and in some cases enormously greater than the circumference of the globe. Such echoes have been frequently noticed during experiments with long distance transmission and reception carried out on the yacht " Elettra " and at many other stations where I have carried out researches. I shall mention here chiefly those echoes which have evidently gone through very great distances.

If, for example, by means of a short wave radiator, we transmit at intervals brief impulses or signals, such as the dots of the Morse alphabet, we can often, when the conditions are favourable, hear and also record on a neighbourhing receiver or oscillographic device, after a time which may vary from a fraction of a second to several seconds and even minutes, a faithful repetition of the same signal. This would indicate that our signal, before returning to us, has traversed hundreds or thousands or even millions of kilometres, according to the greater or less shortness of the interval intervening between the transmission of the signal and the perception of the echo.

Cause of Multiple Signals.

It more frequently happens that a first repetition of the signal reaches us, as has been observed by Quack, about a seventh of a second after the transmission of the original signal and that other repetitions then follow with the same rhythm, but getting weaker and weaker ; this would indicate that our signal has gone several times completely round the earth taking just the time required by the speed of electric waves which we know to be exactly equal to that of light.

How are these phenomena explained ?

In the first place, as regards the signals which appear to go complete one or more times round the earth, it has been noticed that the phenomenon occurs when the conditions of space are such as to cause only a minimum absorption of the energy of the wave used and these conditions occur specially in the vicinity of the equinoxes and towards the hours of dawn and of sunset at the observing station.

It has furthermore been possible to ascertain, by the indications of radio-goniometers, which reveal with precision the direction of origin of the waves, that they go completely round the globe following in preference a zone of space exposed to the penumbra of sunlight, the so-called crepuscular zone.

* T. L. Eckersley : Proceedings of the Institute of Radio Engineers, Vol. 18, No. 1, January, 1930.

In 1928 Professor Stormer of Oslo announced that he had been able to confirm the observations made by Engineer Hals with regard to the existence of radio echoes received several seconds after the transmission of each signal. In view of the fact that the velocity of electric waves is about 300,000 km. per second, it is necessary to suppose that the waves causing the echo traverse in certain cases hundreds of thousands of kilometres. In fact in the course of a lecture given at Edinburgh in February this year Professor Stormer expressed a doubt as to whether some of the waves used in the various transmissions were reflected by the orbit of the moon*.

Studies proceeding from Professor Pedersen and others have shown the possibility that the so-called short waves, used for radiotelegraphy, might in certain circumstances cross the Heaviside space and emerge in interplanetary spaces.

The hypothesis of Stormer is however that these waves are reflected at a great distance from the terrestrial globe by electric strata or by electrons projected by the sun. Electrified particles, which emanated from the sun and happened to be under the influence of the terrestrial magnetic field would be bent round in a toroidal zone at a great distance from the earth. The electric waves radiated by our apparatus after having crossed the Heaviside layer would be shut off and reflected towards the earth by the internal surface of this zone.

According to Pedersen, however, and especially with regard to the echoes whose interval from the original signal is greater than about a minute, it is probable that the waves are deflected or reflected by bands or zones of ions situated outside the influence of the terrestrial magnetic field, endowed with a sufficient density of electrons and capable of producing formations such as to serve as reflectors of the waves, which, after undergoing one or more reflections would return to the earth. It is therefore possible that the echoes with a long interval may be caused by zones or bands of ions which, branching from the sun, extend into space and act on our electric waves at a great distance from the earth.

But there is more still. According to the study published by Pedersen†, to which I would refer those who wish to go deeply into this matter, electric echoes can also be obtained which would indicate that the reflecting layer or zone may even be at a distance of 40 million kilometers from the earth.

Engineer Hals has reported that he has observed these echoes after intervals of 3 minutes 15 seconds and even 4 minutes 20 seconds.

If we always bear in mind the fact that the speed of electric waves is 300 thousand kilometres per second, these observations would indicate that the distance traversed by these waves is 58,500,000 and 78 million kilometres respectively.

Seventy-eight million kilometres ! If this is true, what enormous progress has already been realised since the time of my first experiments when these same waves could be perceived at a distance of about 20 metres at the most !

* Proceedings of the Royal Society of Edinburgh, Vol. L., Part II. (No. 15), 1930.
† P. O. Pedersen Det Kgl. Danske Videnskabernes Selskab. Mathematisk fysiske Meddlelelser ; IX., 5 Copenhagen, 1929.

It should however be recalled that some physicists, such as Van der Pol, deny that electric waves can go outside the terrestrial atmosphere and thus traverse enormous distances. They explain the delay in the echo or return signals by the hypothesis that this is caused by a special electronic distribution of the Heaviside layer capable of greatly reducing the group velocity as compared with the phase velocity. But this explanation is contested by several scientists, among them Pedersen. I am rather favourable to the hypotheses of the latter since I do not see the reason why there should be excluded the possibility of waves of a certain frequency transmitted by us crossing the Heaviside or other layers, since these layers are all crossed by a multiplicity of phenomena, effects and waves which reach us from the sun, primarily among them heat and light.

An important study of the theories of the propagation of electric waves has been made and published by Professor G. Vanni*, and an interesting compendium of studies made on the same subject has been compiled by Ing. Raffaele Marsili†.

In order to explain the phenomenon of the transmission of electric waves to long distances on the earth the hypothesis is necessary not only of a single conducting, refracting or reflecting layer but of several of these layers, and in order to explain many echo phenomena it is necessary to imagine yet other layers at distances of thousands or millions of kilometres, capable of refracting or reflecting the electric waves now used in radio transmissions.

Recent observations lead to the belief that the zone in which the electric wave ordinarily travels when it traverses great distances is a function of the length or frequency of oscillation of the wave itself. But of capital importance in this connection is also the angle, with respect to the surface of the earth, at which the waves are radiated or projected by the transmitting stations.

Studies made on this subject and also with regard to the angle of arrival of the waves coming from distant stations have not only facilitated the attainment of still better and more regular communications between distant countries, but have also given us a means of, I would say as it were, exploring electrically the space around us and determining the height and variations of height of the said Heaviside layer, as also of other zones or layers existing at a more or less great distance from the earth, which zones facilitate or impede the transmission of waves of various lengths to definite distances.

Ultra Short Wave Transmission.

As regards the public radiotelephonic transmissions now effected regularly between Italy and Sardinia, I decided to use a very short wave, of less than 10 metres (30.604 kilocycles), which waves were never before used for continuous and commercial services. From measurements effected very recently it would seem that along the route between Sardinia and the Italian mainland, this wave is refracted and contained within a space lying between the surface of the earth and a layer situated somewhat lower than the Heaviside layer. Could this be that already indicated by Loewestein at a height of only 11 kilometres ?

* Prof. Giuseppe Vanni : Rivista Radio, No. 2-3, 1929.

† Ing. Raffaele Marsili : Volume Dati e Memorie sulle Radiocommunicazioni. Consiglio Nazionale delle Ricerche.

At these stations there has also been put on record with certainty, a few days ago, the existence of echoes, never before observed, as far as I am aware, with such short waves.

Observations on the behaviour of waves longer than 10 metres seem to have established the fact that they are not confined to a restricted space near the earth.

The propagation of electric waves over great distances still depends on a series of unknown factors which are being investigated and which have apparently to do with the electric and magnetic forces of the universe, among which we should not forget the *auroræ boreales* and above all our omnipotent sun. Who knows where these investigations will lead us ?

In the modern practice of radio communications echoes have already a considerable importance. If they do not exert a seriously prejudicial effect on radiotelegraphy and radiotelephony they nevertheless exert a deleterious effect on the radio transmission of pictures and in long distance television, because these repetitions of impulses and signals tend to obscure and confuse the pictures.

Eckersley* in one of his papers, deals very extensively with the effect of echoes or multiple signals and supplies graphs which show the effects of this phenomenon which, together with the variations of intensity in the signals, constitutes the principal obstacle to the practical realisation of the new marvel—distant vision or television.

Very important researches on this subject are in progress in many parts of the world and I am certain that the progress recently obtained in the stabilisation of frequencies and in the transmission and reception of beam waves will tend towards surmounting the difficulties which still stand in the way of the practical realisation of long distance television.

Limitation of Present Knowledge.

In conclusion I may say that I am very far from knowing how fully to utilise the portentous possibilities afforded to us by electric waves. But our knowledge of the behaviour of these waves, as of that of the space which surrounds us, increases every day, leaving, however, on many of us the impression that in at least equal proportions there also extends the field of knowledge which still remains for us to acquire.

The great conquests already made allow us, nevertheless, to assert now with certainty that by means of electric waves mankind not only has available a new and powerful means of scientific research but is conquering a new force and utilising a new arm of civilisation and progress which knows no frontiers and can even push out into infinite spaces where never before perhaps has the feeling or any manifestation of the activity and thought of man been able to penetrate.

This new force which is taking an ever more decisive part in the evolution of human civilisation is certainly destined for the general good by promoting knowledge of each other among nations, thus favouring peace, permitting us to satisfy more and more an essentially human desire, i.e., to be able to communicate with each other with ease and rapidity, thus annihilating that powerful element of separation which is called distance.

* T. L. Eckersley : Work quoted.

COASTAL AND HARBOUR WIRELESS SERVICES

The object of the following article is to enlighten readers, more especially those interested in the use of Wireless as a means of increasing the efficiency of Coastal and Harbour Services, as to the research and development work carried out by the Marconi Company in order that their clients amongst the world's Harbour and Coastal Authorities should obtain from Wireless the greatest possible assistance in their task of ensuring the safety of life and property at sea. Equipments in general are briefly described in the article and mention is made of the more recent applications of the Wireless art to marine navigation.

TO afford a means of communication between ships, and between ships and shore, was the first and more obvious application of the wireless art and having turned its attention in this direction almost immediately after Senator Marconi's early experiments had astonished the world, the Marconi Company has well over a quarter of a century's experience of marine Wireless communication to its credit.

Most nations depend to a large degree for their prosperity and importance upon the extent of their sea-borne trade, in the recent phenomenal growth of which Wireless has played no small part. Until the beginning of the present century every vessel was entirely cut off from the rest of the world for the duration of each voyage, yet to-day, any ship fitted with Wireless Equipment, no matter what her position, can maintain communication with one or other of the countless land and ship stations scattered over the surface of the world. Furthermore, there are in existence excellent services for reporting and forecasting weather, and giving time signals and news of which ships may avail themselves. Broadcast entertainment helps to improve the lot of those at sea ; fishing fleets denied the luxury of skilled operating personnel make valuable use of Wireless Telephone communication ; and passengers in the larger liners are in telephone touch with their offices and homes. But important though all these applications of the art undoubtedly are, there can be no question that Wireless confers an equally great boon to shipping in its application to navigation, and hence in the increased efficiency of the services of Coastal and Harbour Authorities.

A recent issue of THE MARCONI REVIEW* contained an article describing the work carried out by the Marconi Company in developing marine direction finding receivers, and the purpose of the present article is to discuss the beacons and other equipments of direct interest to the Coastal and Harbour Authorities, rather than to the mariner, to whom, however, they render service of inestimable value.

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* No. 29, March-April, 1931.

Direction Finders for Coast Stations.

With the advent of the Valve Amplifier in the year 1915 or thereabouts, the practical development of radio direction finders became possible, soon after which Coastal Direction Finding Stations came into being for the purpose of furnishing ships with directional assistance. Such a station is able to determine to an accurate degree the direction of the signals transmitted from a vessel, and, with the aid of one or more satellite stations, to plot the position of the vessel, which information may then be transmitted to the Captain. Alternatively the observations may be given to the Captain so that the co-ordination of the Bearings can be performed under his supervision.

Although the almost universal adoption of the Marine Direction Finding Receiver, by means of which the Captain may obtain directional observations quite independently of any particular shore stations, has lessened the need for Coastal Direction Finding Stations, these latter are still able to render service of extreme value to such vessels as those having no skilled operating personnel, and they remain, therefore, in considerable demand.

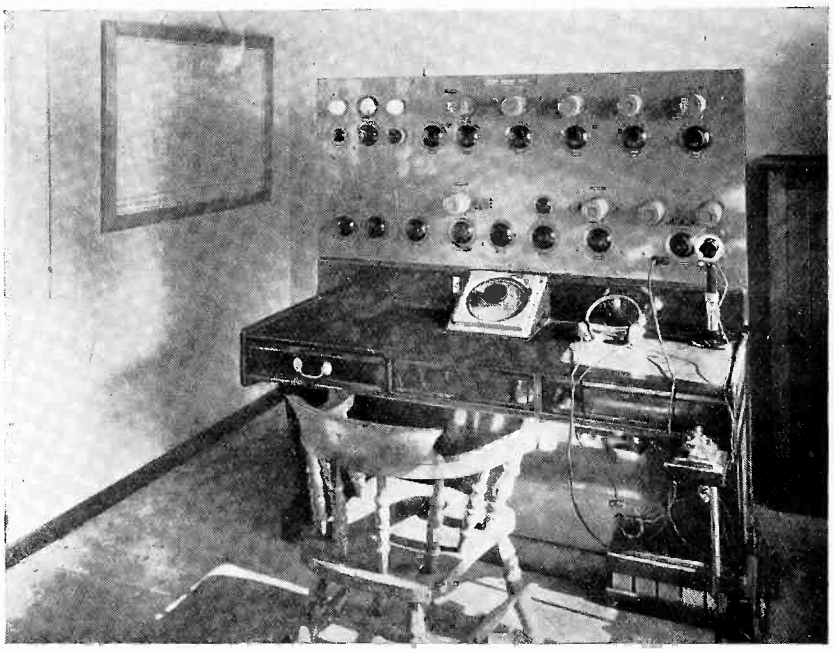
Type has succeeded type from time to time as the Company, in accordance with its general practice, has found it possible to embody new developments in the apparatus. Until recently, however, all direction finders have been unreliable during the period from about an hour before sunset to about one hour after sunrise, a defect of serious import. Now, however, after exhaustive research work, the Company has placed on the market the type D.F.G.8 Direction Finding Receiver, incorporating the Marconi-Adcock methods of night error elimination. Fundamental considerations preclude the development of portable or mobile direction finders featuring night error immunity, and it would appear, therefore, that the Coastal Direction Finder may now gain considerable justification for its continued existence.

The type D.F.G.8, a direction finder employing the Marconi-Adcock system, comprises in the main, four aerials, each suspended within a 70 foot wood lattice tower, and tubular feeders connecting the aerials to the goniometer which forms part of the single instrument unit. Design of the Receiver, which comprises four screened grid high frequency amplifiers, detector, two low frequency amplifiers, an oscillator and a phasing unit, has been most carefully carried out, resulting in an excellent and imposing appearance combined with efficiency of performance and simplicity of manipulation. Two models, differing only in the wavebands they embrace, are available, namely, the types D.F.G.8a and D.F.G.8b, for 500—1,100 and 800—1,800 metres respectively.

The Non-Directional Beacon.

It is probably unnecessary to point out that in order to make use of a marine direction finder, observations may be made on the signals emanating from any

transmitting station whose position is known. The many broadcasting stations, for instance, form excellent beacons, working as they do continuously throughout the greater part of the day and night, but there is, nevertheless, a definite need for beacon stations, whose sole object is to ensure the existence of signals at definite times from known points of reference.



Type D.F.G.8 Marconi-Adcock Direction Finder.

That every country possessing a seaboard recognises its obligations to mariners is evidenced by the navigational facilities freely provided. For centuries these were confined to aural and visual signals, such as lighthouses, lightships, flares, fog-guns, bells, syrens and the like, all of which suffer from the disadvantages of extremely limited range and ineffectiveness in conditions of bad visibility. The development of the wireless beacon has enabled the authorities responsible for these services, to make a tremendous advance in their efficiency, and the existence of some 200 beacon stations in various parts of the world is sufficient testimony to the reception accorded this new navigational aid.

Appreciating from the first that even in the more populous countries, beacon stations would usually be installed in lightships and lighthouses, where skilled personnel would not be available and access for periodical inspection might be difficult, if not impossible at times, the Marconi Company, working in close collabora-

tion with the foremost authorities, has devoted a considerable proportion of its resources to the development of automatic apparatus and simplified control mechanism, culminating in the type W.B.2b equipment, which may be arranged for entirely automatic starting, stopping, controlling and battery charging, no attention of any sort being necessary beyond the occasional replenishment of fuel and oil supplies. Duplication of running machinery may be a feature if desired, in which case apparatus may be provided for the automatic selection of the correct machine when either is faulty. No fear need be entertained, therefore, that the modern wireless beacon is too complicated for installation in uncivilised localities. Conditions in general could not well be less favourable than those obtaining at the Chinese North Saddle beacon site, yet the Marconi beacon recently installed there, at the instigation of the Honourable Corporation of Trinity House, continues to give the utmost satisfaction.

Provided that it is convenient for an occasional visit to be made by an Inspecting Engineer, a highly efficient service is assured equal to that rendered by the numerous beacons operating around the British coast. The light or other normal staff will quickly gain proficiency in making slight adjustments or at least in reporting intelligently upon breakdowns, which, though rare, can occur with even the finest British machinery.

Having an aerial energy of approximately 350 watts the type W.B.2 Beacon is suitable for most requirements, but a less powerful edition is available for special circumstances.

Obviously a beacon is seldom more desirable than in a lightship, the existence of the one implying a need for the other, and the Company's experience naturally embraces numerous installations in vessels offering very restricted accommodation for apparatus and aerial. The difficulties, however, have never proved to be insurmountable, a 100 watt edition of the type W.B.2 beacon generally meeting the case, the curtailment of power, and hence of the service range, being unavoidable.

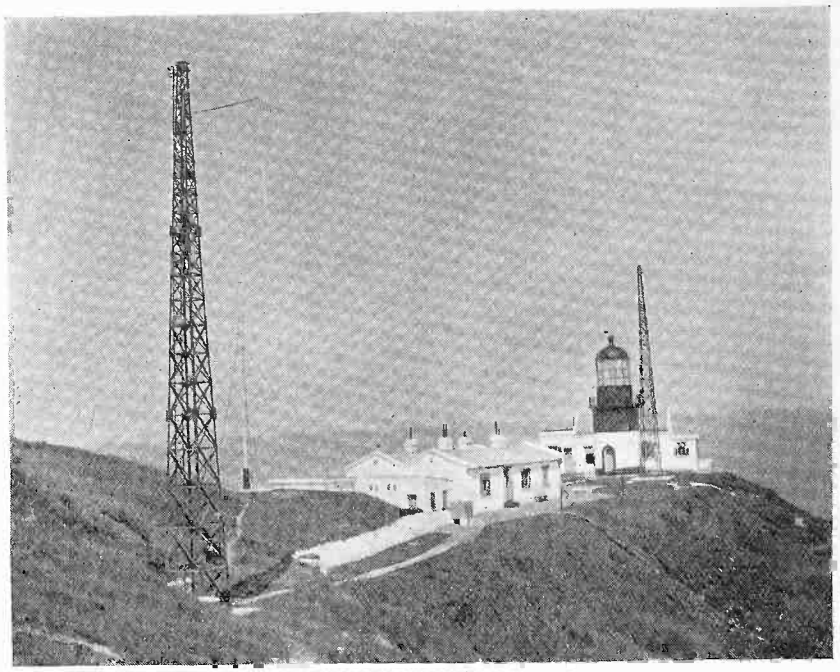
Directional Beacons.

Theoretically an aerial system capable of directional reception is equally capable of directional transmission and the Marconi Company's activities have included, not without a considerable measure of success, investigation of the possibilities of evolving beacon apparatus which would at one and the same time furnish the navigator with signals and an indication as to his direction in relation to the beacon.

As far back as the year 1920 the Company installed at Inchkeith, Scotland, the Marconi-Franklin Revolving Beacon, which suffered from the single disadvantage that practical considerations limited the wavelength to 10 metres or less.

With a similar object in view, technical experts of the British Air Ministry have developed a closed, rotating loop transmitter, which, though dating in principle

from the time of Hertz, is entitled to recognition as the first practical directional beacon working on wavelengths of the order of 950/1,050 metres and serving all directions equally.



North Saddle Wireless Beacon Installation.

A closed loop unfortunately, is an inefficient radiating system and a very considerable amount of power must necessarily be expended in order to ensure a satisfactory service range of the order of 100 miles. Difficulties in design of frame, brush gear and rotation governing mechanism have now been successfully overcome and irregularities in the transmitted space pattern due to absorption and reradiation by local obstacles have been avoided by the care displayed in the design of apparatus and the building in which it is housed.

Simplicity itself in design, it is, perhaps, desirable briefly to explain the principles underlying the operation of the beacon. The radiated space pattern is, of course, the familiar figure 8 and if the loop is arranged to rotate through 360° in one minute, the distant listener observes, by means of an ordinary wireless receiver alternate minima and maxima at 15 seconds intervals.

Bearings may be taken by means of an ordinary stop watch, preferably calibrated in compass degrees. A characteristic signal is emitted when maximum

radiation is in the North and South line, upon hearing which the observer starts his stopwatch, stopping it again when signal strength reaches a minimum. The bearing may then be read directly from the compass watch-dial, or, in the case of the ordinary dial, may be taken as six times the reading in seconds. The transmission of a second characteristic signal in the East-West line of maximum radiation provides an alternative datum line for use when the observers minimum signals happen to coincide with the North signal. A moment's consideration will show that this type of beacon suffers from 180° ambiguity, which, however, is seldom troublesome. In common with other directional beacons the rotating loop type has numerous advantages, not the least important of which is that rolling of the vessel in no way affects the accuracy of the observations. Others will readily occur to the reader, but the fact must not be overlooked that the range limitation alone is sufficient guarantee that this new navigational aid can never entirely supplant the marine direction finding receiver.

By co-ordination of two bearings, the second being obtained from a similar beacon or from any other source, the observer can, of course, fix his position.

The Marconi Company is privileged to market a beacon transmitter embodying the experience of the Air Ministry Technical Officials, in addition to the knowledge gained by themselves in their research, experimental and practical work, on all forms of directional transmission and reception. Possessing all the leading features of the well known "Orfordness" rotating beacon, but incorporating numerous refinements, the Marconi Rotating Loop Beacon is assured of a permanent place amongst the navigational aids the Company has been able to place at the disposal of the mariner.

Whilst discussing directional beacons, mention must be made of the equi-signal system, which has not so far been adopted for marine navigation, but is nevertheless worthy of consideration for certain special circumstances.

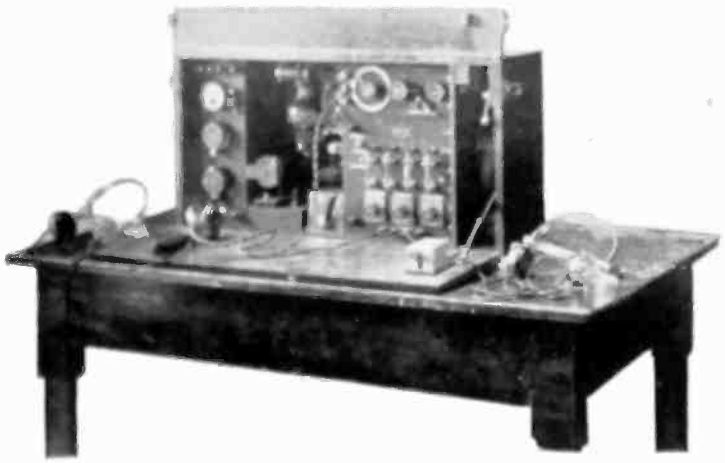
In brief, this type of beacon is essentially for "homing" purposes, that is to say, its function is to provide a straight path or paths in predetermined directions to and from the beacon. No indication is given as to the bearing of the craft from the beacon and although a certain amount of use might be made of the directional signals by craft crossing the equi-signal path the assistance rendered by the beacon is intended to be reserved to those having to navigate along the equi-signal course, which fact would normally preclude its marine adoption.

The system in its simplest form comprises two loop aerials fixed at right angles to each other, and at 45° to the airway or other desired path, each loop having its own oscillation generator. In operation, the loops emit interlocking Morse characters, that is to say, although both are tuned to the same wavelength "marking" on one

loop is arranged to coincide with " spacing " on the other, so that one or the other is always energised, but never the two at the same instant. Diagramatically the effect is as follows when the letters F and L are used :—

Loop A
Loop B
Resultant

Clearly the " on course " signal will be a continuous dash of unvarying strength, but deviation to the extent of only 1° or so will be immediately indicated by the ensuing irregularity of strength. This irregularity becomes more pronounced as the deviation increases, until at a few degrees off course, the predominating letter is easily recognised and the navigator is aware of the direction in which to turn in order to regain signal strength equality.



Mersey Dock and Harbour Board Radio-telephone Installation, 1921.

Visual indication of strength equality, or of degrees on or off course, can be arranged by means of suitable equipment at the receiving station working in conjunction with a beacon transmitter of more complicated design, but as the usefulness of the equi-signal system is almost entirely restricted to aerial navigation, it is not necessary to devote space in this article to a more detailed description of its features.

In passing, however, it is interesting to note that by means of a special radio goniometer the equi-signal zone may be oriented in any desired direction, without regard to the relationship the loops themselves bear to that direction. Moreover by means of a more complicated goniometer in conjunction with a single pair of loops, it is possible to emit a multiplicity of equi-signal zones.

Lightship, Lighthouse and Harbour Communication Services.

Pioneers in almost every field, the Marconi Company supplied to the Mersey Dock and Harbour Board in the year 1921, telephone communication sets for communication between the Bar Lightship and the Dock Offices, and the Company thus has the honour of having been responsible for the world's first commercial wireless telephone stations.

A simple and reliable means of communication between lightships, lighthouses, tugs, dredgers, pilot boats, shore depots and Seaport Administrative Offices had long been sought, and a variety of methods had been tried without avail. The introduction of wireless as a solution was impracticable before the development of telephony, owing to the fact that Morse reading was beyond the capabilities of the users, often aged seafaring men.

Over a period of several years wireless telephony has proved its reliability and value, if indeed, proof of the latter were necessary, but the continuous attention of the Company has been directed to the problem of developing apparatus so simple of manipulation, that persons lacking entirely a knowledge of the principles of wireless communication, and in fact, without any electrical training whatever, should experience no difficulty in operating the apparatus.

Their success in this direction is reflected in the numerous orders received for the type " X.M." sets, the popularity of which is borne out by letters of appreciation received from almost every corner of the civilised globe.

Three editions rated respectively at 100, 250 and 500 watts complete the " X.M." series, there being comparatively little difference in their general features.

All working parts of the sets are enclosed in metal panels, the transmitter working on a selected fixed wavelength, and the only control accessible to the operator being the handle operating the " send/receive " and battery charging switch, which also stops and starts the motor generator. In addition there are the controls for tuning and reaction adjustments of the highly efficient receiver.

The Calling Device.

In addition to their special application to Harbour Services, the type " X.M." sets have proved to be equally useful for installation in small fishing vessels and lifeboats and for the conduct of point to point services ashore. A definite demand arose, however, for a means of attracting the attention of a station at which a continuous watch cannot conveniently be maintained, and as a result, the Marconi " Call " apparatus was designed.

The latest edition, the type C.g3, whilst suitable for use with any telephone set is supplied more frequently with the " X.M." type of sets than with any other, as

these are usually installed where no trained personnel are employed and consequently no continuous watch is kept.

The very ingenious construction of the Marconi " Call " Equipment need not be dwelt upon. Suffice it to say that its function is to enable a caller to attract the attention, by means of a bell or other audible signal, of the desired station staff, without, however, having the least effect upon " call " receivers installed at other nearby stations, even though these may be tuned to the same wavelength.

Operation of the device is extremely simple and in view of its extraordinary reliability and virtual immunity from false calls there is no doubt that it has filled a long felt want.

Conclusion.

Special modifications of the equipments mentioned above and various equipments of insufficient general interest to come within the scope of this article, have from time to time been supplied to satisfy special requirements.

For instance, beacon transmitters have been modified to be capable of acting when necessary as ordinary telegraph transmitters. Such a transmitter with the addition of a suitable receiver comprises a complete station for ordinary marine or other telegraphic communication duties, the modifications including provision for changing the wavelength.

Again, a submarine signalling device, which, however, is not of Marconi manufacture, is occasionally supplied by the Company for installation on lightships together with beacons of the omni-directional type. The object of the device is to enable navigators to estimate their distance as well as their direction from the beacon. The wireless and submarine transmitters are arranged to transmit simultaneously a series of regularly spaced dots, which signals reach the observer, in the case of the former, through æther at almost instantaneous speed and in the case of the latter, through water at some 4,800 feet per second.

By counting the number of dots received by wireless before the arrival of the first dot by water computation of distance from the source of the signals becomes simple.

More detailed information regarding any or all of the equipments mentioned and the advice of the Company on special problems are at all times available, but this article will have served its purpose if it proves to be of assistance to Authorities charged with the duty of organizing a new, or modernising an existing service.

SHIP TO SHORE TELEPHONE INSTALLATION ON THE S.S. EMPRESS OF BRITAIN

The difficulties associated with long distance ship-to-shore telephony, and the methods used to overcome them, are outlined in the following description of the wireless telephone installation in the "Empress of Britain," executed by the Marconi Wireless Telegraph Company, Limited, an analogous installation to that existing on the White Star Liner "Homeric," which was described in the MARCONI REVIEW *No. 30 for May-June, 1931.*

A special feature of the "Empress of Britain" equipment is the ability to speak from the ordinary cabin telephones which are connected to the wireless telephone through the ship's manual switchboard, so that telephone service to or from the ship is as convenient as the normal shore telephone service.

THE development of long range ship-to-shore telephony as a commercial project has been rendered possible by the use of short waves between 16 and 70 metres and has been brought to the present high standard of technical efficiency and organisation, during the past two years, by the Marconi Company in conjunction with the wireless section of the Post Office in England and with the co-operation of the American Telephone and Telegraph Company in America, all of these organisations having erected new stations and provided specialised staff to deal with this service.

The provision of a comparatively high power and good quality duplex Radio Telephone Service, where the transmitter and receiver, with their associated aerials, have to be installed within a few hundred feet of each other, possesses its own particular problems. Some of these may be easily visualised if one remembers that the energy in the transmitting aerial is approximately the same as that used in the first chain of Broadcasting Stations erected by the B.B.C., such as 2 LO London, and similar stations at Birmingham, Manchester, etc., and that to provide a duplex service is equivalent to receiving the distant station while being situated next door to one's local station.

In the case of commercial radio services on shore the transmitting and receiving stations are usually separated by anything from 20 to 100 miles—as in the case of the British Post Office with their transmitting station at Rugby and the receiving stations at Baldock near St. Albans, a separation of approximately 60 miles, and Cupar, Fifeshire, a separation of approximately 350 miles.

Another difficulty in providing a radio telephone service on ship is that the local carrier induces currents in the ship's rigging, ventilators and fan casings, etc., and with the usual loose contacts that exist these currents produce a form of static

which would spoil reception. The normal vibration associated with a ship must not be neglected or trouble of another form will be experienced.

The above brief outline of the conditions to be met, will assist in following the description of the radio telephone installation on the "Empress of Britain," a schematic diagram of which is shown in Fig. 3.

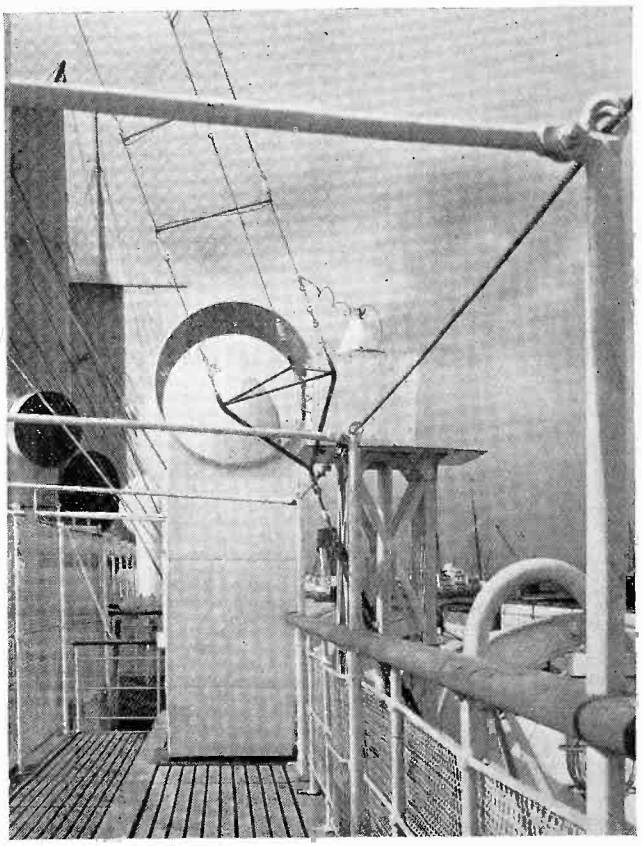


FIG. 1.

General Disposition of Equipment.

The transmitting room is situated on the Sun Deck and partly inside the forward portion of the after funnel and the receiving room is on the same deck between the middle and forward funnels.

The telephone transmitting aerials are slung from the halyard supporting the main wireless aerial in the open space between the after funnel and mast and above the tennis court, while the receiving aerials are slung between the forward mast and the port and starboard sides of the searchlight bridge, below the navigating bridge.

Radio energy is conveyed to and from these aerials by means of concentric copper tube feeders an arrangement which provides complete protection to passengers and crew as the outer tube is at earth potential and completely encloses the "live" conductor. The energy loss in this type of feeder being very low, the length employed is a negligible factor and allows the most convenient positions to be used for housing the apparatus while the aerials are erected in the most suitable position from a technical viewpoint.

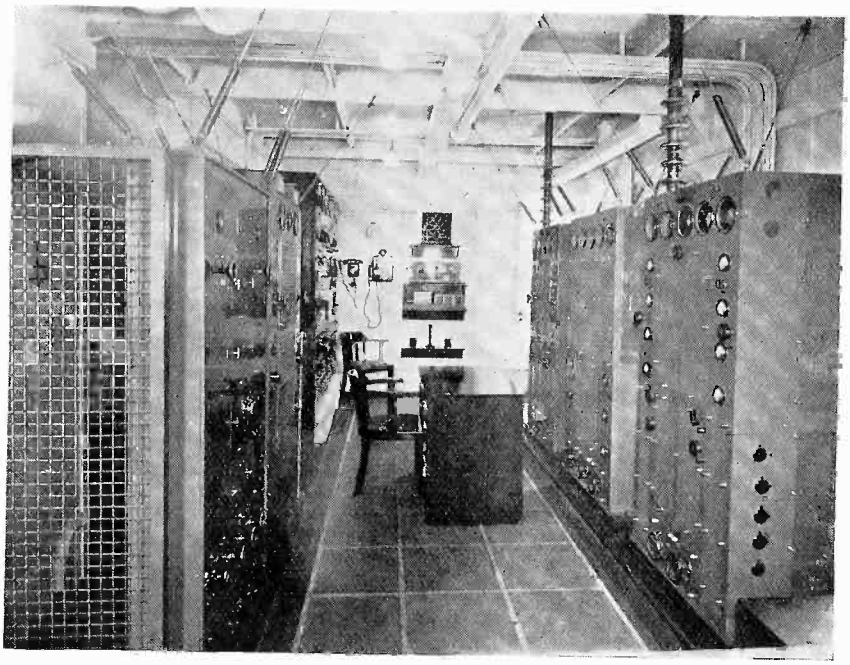


FIG. 2.

The aerials used are mainly of the Franklin omni-directional type, Fig. 1, but those for the shorter wavelengths have a definite area of concentration in the vertical plane.

Power for the transmitter is drawn from two motor generator sets driven from the ship's mains and located in the main switchboard room of the vessel but started and controlled from the telephone transmitting room. One generator delivers 22 volts direct current for heating the filaments of the power valves in the transmitter and modulator panels and for charging the 6-volt batteries used for heating the filaments of the Master Oscillator valves. The second generator supplies 500 volts alternating current at 500 cycles from which all other necessary supplies are obtained through suitable transformers and rectifiers.

Transmitting Room.

The apparatus in the Transmitting Room is contained in five separate units and is shown in Fig. 2. All units are of such a size that they will pass through the standard doorway of a ship's cabin without dismantling. On the left of the photograph are shown the switchboard controlling the two generators with the respective distributing switches, the main rectifier panel for the provision of the 5,000 volts D.C. required for the anode supply to the main power valves, and a second panel containing four small rectifier units for the provision of anode supply to the master oscillators and the various grid bias supplies.

On the right of the photograph are the two short wave oscillator panels with a common modulator panel in between. All panels are of the latest pattern and of the fully enclosed protected type, automatic trip switches being incorporated where necessary to protect the staff from accidental shock. A special felt base on which the panels are mounted insulates them from the mechanical vibration common to most ships and any vibration existing is further damped by means of adjustable spring tension devices between the four top corners of the panels and the roof of the cabin.

Both oscillator panels are identical in appearance and general construction, the only difference being in the wave band covered. One oscillator covers from 12,180 kilocycles to 14,100 kilocycles, or approximately 21·2 to 24·6 metres, and the second from 4,060 kilocycles to 4,640 kilocycles, or approximately from 65 to 74 metres, without the use of plug-in coils or switches.

These wavebands are sufficiently wide to provide the necessary channels for the various services required and to provide for further extension of these services. The 21 to 24 metres transmitter is normally used for long distance daylight communication and the 65 to 74 metres transmitter for night and short distance communication.

Air-cooled valves are used in all stages.

The required steadiness of frequency is obtained from a master oscillator situated in the right hand lower corner of each oscillator panel and consists of two separate units. The lower unit contains the oscillatory circuit and is supported in a rubber-lined cradle as a further protection against vibration. A novel form of valve oscillator circuit is used and the frequency is unaffected by normal changes of low tension or high tension supply. The circuit is self-compensating against temperature changes and the use of ovens with thermostatically controlled heaters common to most other forms of frequency control is avoided. The main condenser of this unit is provided with a vernier scale, and a calibration chart is supplied which permits the operator to set the transmitter to any required frequency within its range or to change the frequency as required.

The second unit contains the necessary amplifying and frequency changing stages until sufficient energy is obtained to drive the first power stage at the operating frequency.

The three power stages are all of the same general type, being capacity bridge balanced circuits with fixed inductive coupling between stages and a novel form of unit construction for the closed circuits.

One M.T.12 valve working at approximately 30 watts input is used in the first power stage and a single M.T.9F valve with approximately 100 watts input for the second power stage, while two M.T.9F valves working in push-pull with 2 kilowatts input are used for the final stage.

With this power in the final stage approximately 1·5 kilowatts of aerial energy is obtained with the transmitter unmodulated.

To avoid the highly damped disturbances produced by the local carrier exciting various radiating circuits in the rigging and other ship's fittings, and producing noise in the local receiver, a voice-operating carrier controlled system is fitted.

This consists of a direct current amplifier system by means of which the subscriber's voice controls the anode supply to the first two power stages, thus controlling radiation from the final power stage. This system maintains the local transmitting aerial in a quiescent condition until modulation is supplied. As the switching-on occurs at almost infinite speed no audible clipping of initial syllables occurs and the speed of switching off when modulation ceases is adjustable at the monitor board over a fairly wide range.

The modulator panel for the system of high power modulation in use consists of three stages with resistance capacity coupling between stages. The first stage consists of a single M.T.4B valve with 25 watts input, the second stage a single M.R.6B valve with 60 watts input, and the final stage four M.T.9L valves in parallel with a total input of 2 kilowatts.

The frequency response of this modulation system is practically flat from 50 to 7,000 cycles and 92 per cent. modulation can be applied without appreciable distortion.

Receiving Room.

The apparatus in the receiving room is mounted in two separate units and is shown in Fig. 4. The right hand unit contains the radio frequency circuits and the left hand unit the audio frequency circuits with terminal and monitoring equipment. Both units are mounted on floating floors with spring damping to roof as in the transmitting room, but the floors are of a slightly more elaborate design.

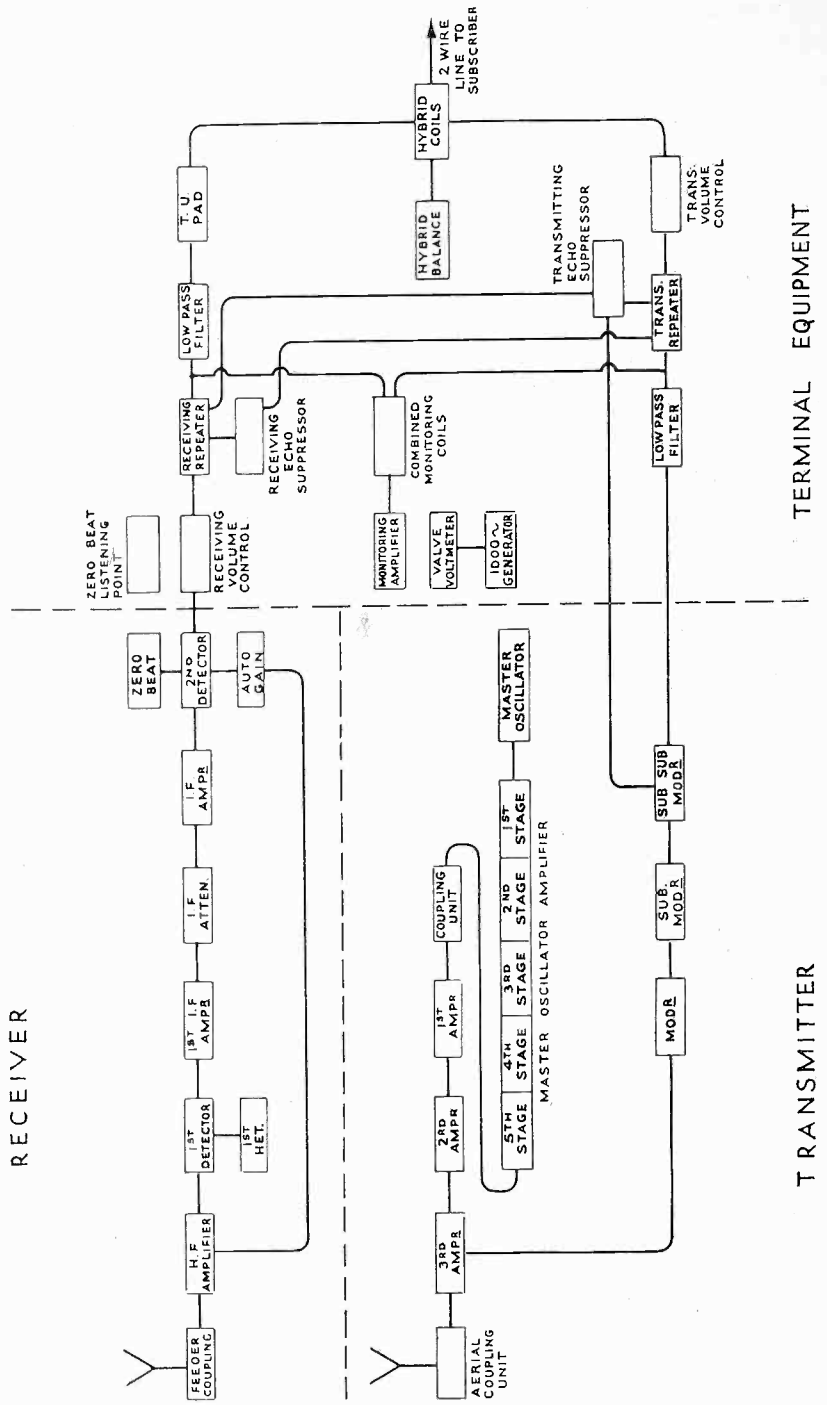

RECEIVER
TRANSMITTER
TERMINAL EQUIPMENT
FEEDER COUPLING
H.F. AMPLIFIER
1ST DETECTOR
1ST HET.
1ST I.F. AMPR
I.F. ATTEN
I.F. AMPR
2ND DETECTOR
ZERO BEAT
AUTO GAIN
ZERO BEAT LISTENING POINT
RECEIVING VOLUME CONTROL
RECEIVING REPEATER
RECEIVING ECHO SUPPRESSOR
LOW PASS FILTER
T.U. PAD
HYBRID COILS
2 WIRE LINE TO SUBSCRIBER
HYBRID BALANCE
COMBINED MONITORING COILS
MONITORING AMPLIFIER
VALVE VOLTMETER
1000~ GENERATOR
TRANSMITTING ECHO SUPPRESSOR
TRANS. VOLUME CONTROL
TRANS. REPEATER
LOW PASS FILTER
SUB SUB MODR
SUB. MODR
MODR
3RD AMPR
2ND AMPR
1ST AMPR
COUPLING UNIT
5TH STAGE
4TH STAGE
3RD STAGE
2ND STAGE
1ST STAGE
MASTER OSCILLATOR AMPLIFIER
MASTER OSCILLATOR
AERIAL COUPLING UNIT

FIG. 3.

All the power supplies for both units are obtained from duplicate composite motor generator sets situated in a small locker on the deck below. These machines are mounted on similar floors to the receiver units to prevent vibration and noise being transmitted to the passenger accommodation.

The short wave receiver, which is mounted along the forward bulkhead is complete with its own switchboard and testing instruments. It has a wavelength

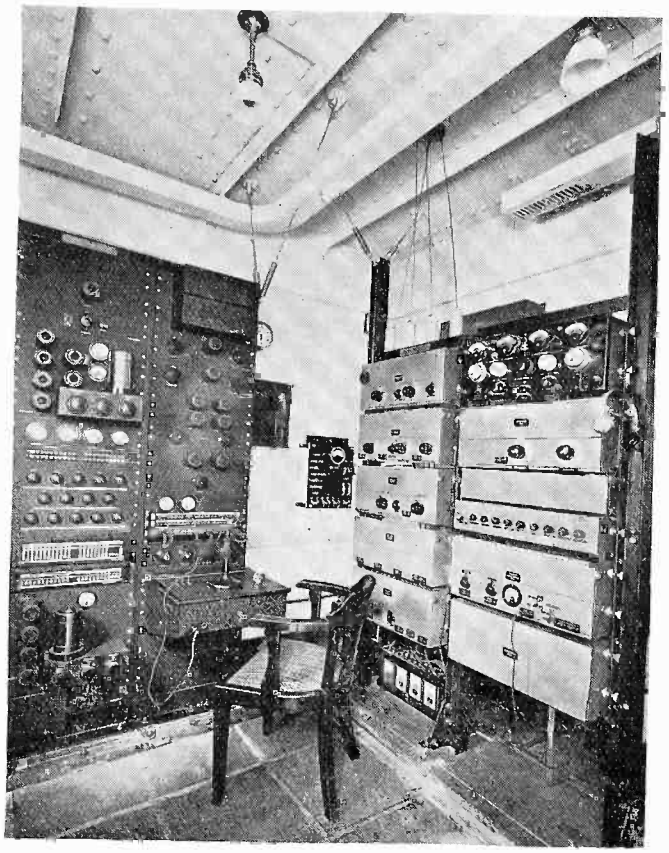


FIG. 4.

range of 14 to 100 metres and is a combination of high frequency amplification followed by intermediate frequency amplification on the superheterodyne principle.

Four stages of transformer coupled screened grid high frequency amplification are available before changing frequency and one of these stages is fitted with optional switches.

The local oscillator for frequency changing is rubber insulated from the adjacent units and frame to eliminate vibration and the power for this valve is drawn from

low tension and high tension batteries in order to avoid possibilities of frequency variation due to variation of the voltage from the ship's mains.

After changing the frequency to 166 kilocycles (approximately 1,800 metres), a further five stages of filter coupled amplification are available, two of these stages being fitted with optional switching. An attenuator unit to operate on this frequency is also incorporated.

A zero beat oscillator is fitted to assist the operator in setting the intermediate frequency to the middle of the band pass of the intermediate frequency stages, the total band width of these stages being approximately 7,000 cycles.

The detector stage of the intermediate amplifier has a further circuit incorporated with it to provide automatic gain control for the high frequency stages, this varies the grid bias on the high frequency valves in accordance with the strength of the incoming signal and compensates for any variation in signal strength due to fading.

Monitoring System.

The terminal unit containing all the audio frequency stages and monitoring operator's equipment, is mounted along the port bulkhead and is complete with its own measuring and testing instruments.

From the output of a radio receiver the incoming speech is passed through the receiving repeater where the strength is adjusted to a level suitable for the subscriber, a valve voltmeter being incorporated for checking this level.

The subscriber's speech is passed through the transmitting repeater and adjusted for level before being passed on to the modulator panel in the transmitting room, a second valve voltmeter being incorporated to indicate level.

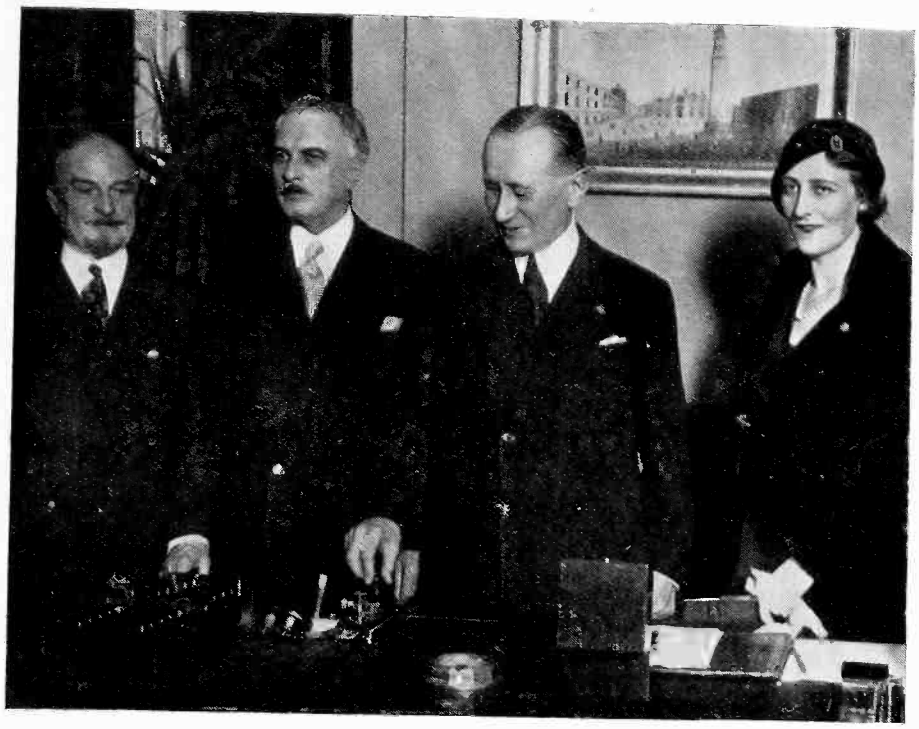
The voice operated carrier control unit is connected in parallel with the output of the transmitting repeater and is provided with its own gain controls and adjustment for delay in switching off the carrier, a relay being incorporated for cutting off the subscriber's receiver while the subscriber is speaking.

A somewhat similar unit is connected in parallel with the receiving repeater to act as an echo suppressor when changing from four wire to two wire working. This change is carried out through hybrid coils and a balancing network to enable the radio telephone installation to be plugged through to any of the telephones connected to the manual or automatic exchanges on board.

A 1,000 cycle valve oscillator is also incorporated in the terminal unit and can be used to modulate the transmitter instead of speech when lining up the circuit. It can also be keyed to enable the operator to telegraph service instructions if desired.

MARCONI NEWS AND NOTES

MARCHESE MARCONI ILLUMINATES STATUE AT A DISTANCE OF 6,000 MILES.



H.E. Marchese Marconi pressing a key in Rome to illuminate the statue of Christ in Rio de Janeiro. Also in the photograph are Marchesa Marconi, H.E. Alceeia def Pecanha, the Brazilian Ambassador in Rome, and (extreme left), Marchese Solari.

HIS EXCELLENCY MARCHESE MARCONI contributed in unique fashion to the celebrations in honour of the anniversary of the discovery of America at Rio de Janeiro on October 12th, when, by sending a wireless signal from Rome, he switched on special floodlights to illuminate the newly erected statue of Christ the Redeemer on the top of the Corcovado Mountain.

The Corcovado Mountain is one of the main features of the landscape of Rio de Janeiro and the sudden illumination of the statue at its summit, just as dusk was falling and 15 minutes before the street lamps were lit in the City, by means of the wireless signal from nearly 6,000 miles away, provided an impressive and awe-inspiring spectacle. The statue stands 130 feet in height, and, with its arms spread in a gesture of benison, overlooks the entire city and the famous harbour.

The wireless signal transmitted by Marchese Marconi consisted of a Morse dash. His Excellency pressed a Morse key in the Marconi Office in Rome and from there the signal was conveyed by landline to the Italian wireless telegraph station at Coltano—about 150 miles from Rome, near Leghorn—which some years ago was christened " Guglielmo Marconi " in honour of the illustrious inventor. The wireless signal thus despatched from Rome was intercepted by the Marconi Beam receiver at the Brazilian Wireless Telegraph Company's station near Rio de Janeiro and thence transmitted over a telephone landline to the base of the Corcovado Monument, where an automatic switching device for controlling the illumination of the monument had been constructed.

The demonstration was similar in principle to that which took place in March, 1930—described in THE MARCONI REVIEW, No. 19—when Marchese Marconi sent a wireless signal from his yacht at Genoa which switched on the lighting in Sydney City Hall at the opening of the Electrical Exhibition in Sydney, New South Wales.

Faraday Centenary.

LONDON paid high tribute to science and engineering during September, when the centenary meeting of the British Association, the centenary celebrations in honour of Michael Faraday, and the Shipping, Engineering and Machinery Exhibition were held in the Metropolis.

Leaders in every branch of scientific thought gathered to make their contribution to the ceremonies and discussions, and at a special Faraday commemorative meeting tributes to the genius of Faraday were paid by, among others, the Rt. Hon. Ramsay MacDonald, Prime Minister, His Excellency Marchese Marconi, Lord Rutherford, Lord Eustace Percy, and General Smuts, President of the British Association.

A special feature of the Faraday Centenary Celebrations was the Faraday Exhibition at the Albert Hall, which demonstrated many of the principal scientific and engineering achievements based upon Faraday's electro-magnetic discoveries, and which attracted many thousands of visitors.

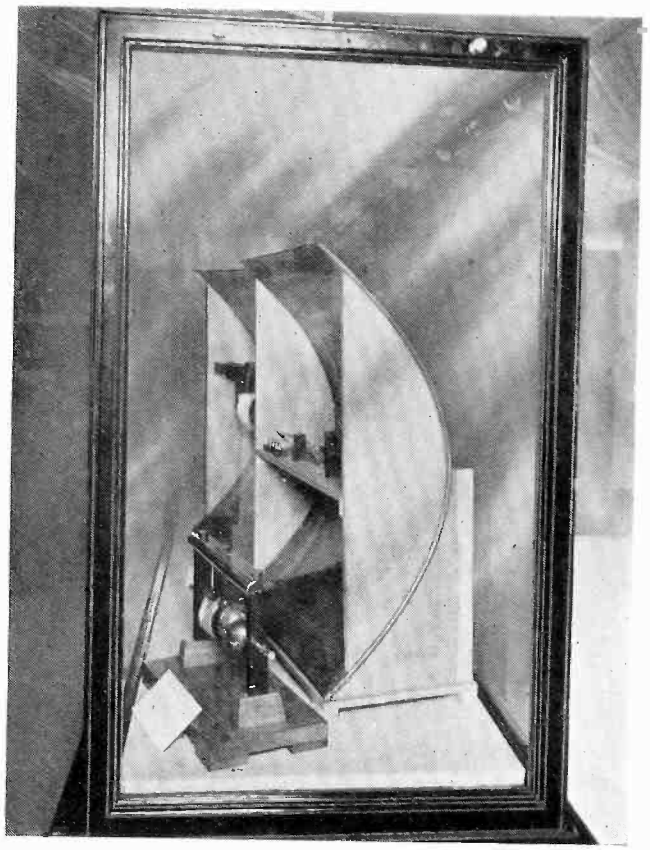
Historical Marconi Exhibits.

The far-reaching effect of Faraday's discoveries was nowhere more strikingly shown than in the exhibits contributed to this Exhibition by the Marconi Company. Though limited in number owing to the space available, they formed one of the most interesting collections of historical wireless apparatus ever seen at an exhibition.

They included replicas of apparatus used by Marchese Marconi in his earliest experiments at Bologna in Italy in 1895, and original apparatus used by him when he first came to England and gave demonstrations to the General Post Office and the Admiralty in London and on Salisbury Plain. There was a coherer

receiver, and early Bellini-Tosi apparatus, consisting of a direction finding receiver and a directional transmitter, of 1907, the one being the forerunner of the direction finder now so largely used on board ship, and the other of the equi-signal beacon which is now being developed for aircraft navigation.

The display also included an arc wireless telephone of 1910, and a series of microphones for wireless telephony illustrating the development of this instrument from the time of the Marzi microphone of 1910 up to the latest Marconi-Reisz type now used in practically all broadcasting stations.



At the Faraday Exhibition: A Righi Oscillator; and replicas of transmitter and receiver with parabolic reflectors as used by Marchese Marconi for communication with ultra-short waves over a distance of $1\frac{3}{4}$ miles on Salisbury Plain in 1896.

One of the most complete historical collections of valves ever shown at any exhibition provided such contrasts as the experimental two-electrode valves made by Sir Ambrose Fleming from 1904 to 1908, and the giant 100-kilowatt valve of to-day which is used in the largest modern broadcasting stations.

Above the exhibit was suspended one of the kites used by Marchese Marconi in the first trans-Atlantic experiments between Poldhu and Signal Hill in Newfoundland, in December, 1901, which first demonstrated the possibility of world-wide wireless telegraph communication.

Owing to the limitations of space the number of Marconi exhibits had to be curtailed and it was not possible to include any modern commercial apparatus. However, the British Broadcasting Corporation had on view a regional transmitter of Marconi manufacture; and the latest type of aircraft transmitter specially designed for fitting in large aeroplanes and airships was shown in another section of the exhibition.

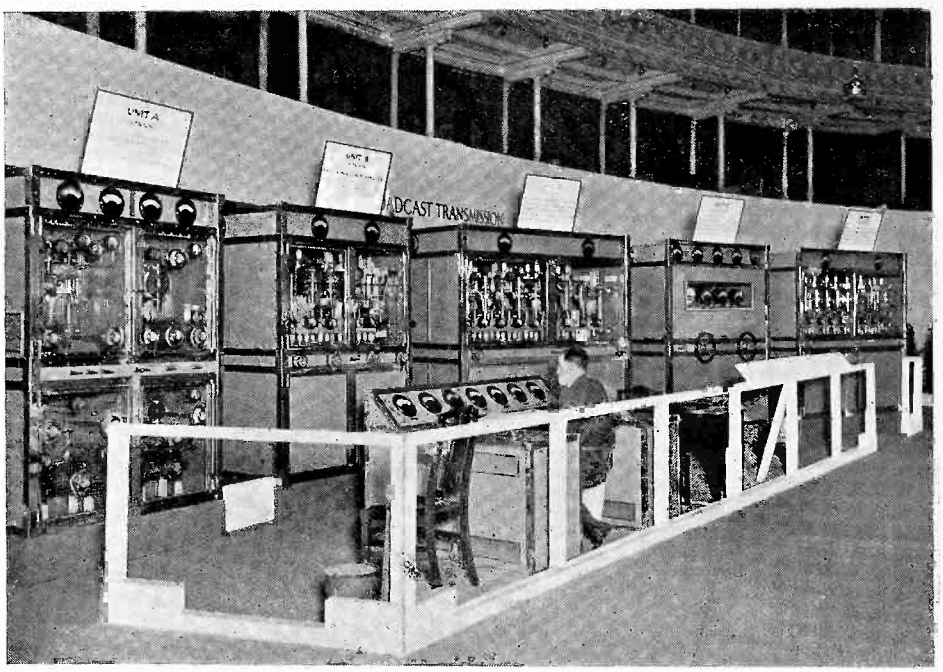
Marconi Equipment Officially Approved.

MANY hundreds of aero-generator windmills developed by the Marconi Company in conjunction with Messrs. Haslam & Newton, of Derby, utilising variable pitched blades operated by means of centrifugal weights are in use in all parts of the world. The British Air Ministry has now notified the Marconi Company that the Marconi-Newton constant speed windmills Types 110, 140, 160 and 180 are approved for use on civil aircraft registered in Great Britain.

Owing to the differing air speeds and other factors involved, the installation of a windmill of any of these types in any particular aircraft registered in Great Britain will be subject to examination in order to ensure its safety on that machine.

The Type 110 windmill has an output up to 100 watts, Type 140 up to 180 watts. Type 160 up to 250 watts, and Type 180 up to 500 watts.

These new models, as approved by the Air Ministry, include important improvements, greater strength and efficiency being obtained by the use of solid blades and a new system of governing, and the general construction being lightened in weight. At the same time head resistance has been reduced.

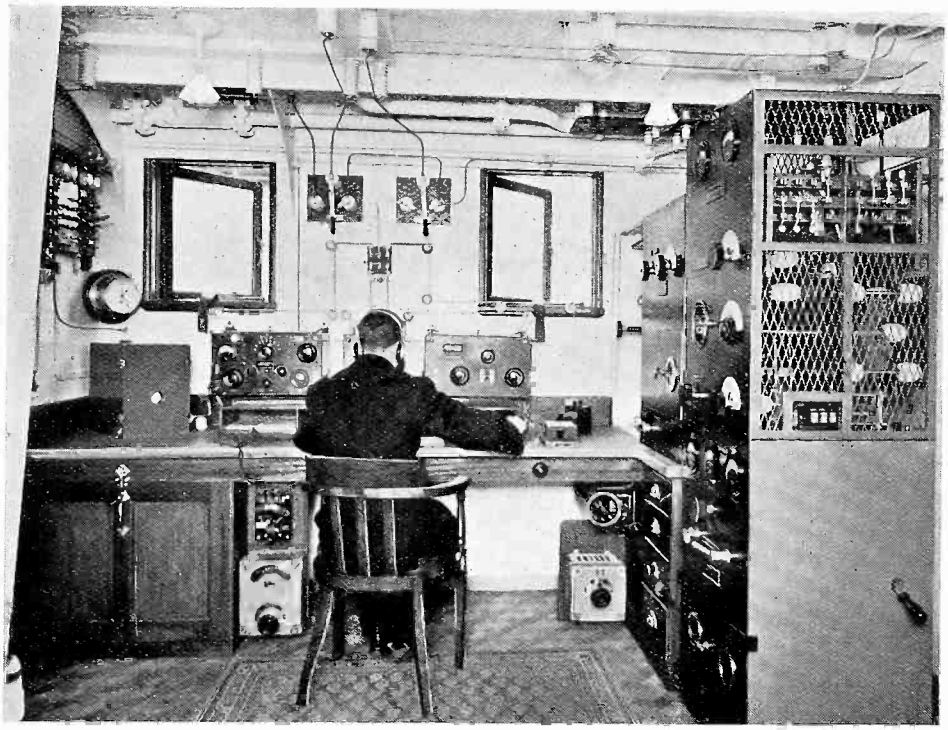


The latest B.B.C. Regional Transmitter, manufactured at the Marconi Works, Chelmsford.

Other Marconi wireless apparatus approved by the Air Ministry for use on civil aircraft registered in Great Britain include the A.D.6h and A.D.6m "all-purpose" 150 watt aircraft telegraph-telephone equipment; A.D.8 long range aircraft telegraph-telephone equipment; A.D.16 aircraft direction finder, Bellini-Tosi system; A.D.18a 350-watt telegraph-telephone transmitter and receiver, the former having an independent "drive" system for maintaining at a constant value the frequency of the radiated wave; A.D.19 150-watt short wave telegraph-telephone transmitter with independent drive, waverange 40-60 metres; A.D.20 short wave receiver waverange 40-60 metres; and A.D.20a short wave receiver, waverange 80-180 metres.

Marconi Marine Telephony.

MODERN Marconi marine equipment was an outstanding feature of this year's Shipping Exhibition at Olympia. The latest installations for wireless telegraphy and telephony, band repeater and music playing equipment, and the Echometer type of Marconi Sounding Device were arranged on a large stand



A modern ship's wireless cabin, showing from left to right: Marconi emergency transmitter, marine receiver (15-20,000 *metres*) *with local oscillator and H.F. amplifier units, and 2 k.w. valve transmitter for long and short wavelengths. The Marconi Direction Finder is fitted in the chart room of this ship.*

on which representative ships' wireless cabins had been built to illustrate in practical fashion the arrangement and fitting of the apparatus.

Guests at the inaugural luncheon of the Exhibition enjoyed a wireless "surprise item," when Lord Wester Wemyss, presiding at the function, received telephone calls from the Captains of the "Empress of Britain" and the "Homeric." Both ships were at the time ploughing their way eastward on the Atlantic, and their Captains were able to voice good wishes to the exhibition through the medium of their Marconi long-distance telephone equipment and the Post Office ship to shore telephone service. The conversations were extremely clear, and were reproduced on loud speakers so that they could be heard by all the guests at the luncheon.

An additional happy significance was given to the occasion by the fact that Sir Austen Chamberlain, First Lord of the Admiralty, was also present at the luncheon, and was able to convey over the wireless telephone circuit the greetings of the Royal Navy to the British Mercantile Marine.

Marconi Equipment for P. & O. Liners.

THE four new liners of the Peninsular and Oriental Steam Navigation Company, "Strathnaver," "Strathaird," "Corfu" and "Carthage," are each to carry the latest type of Marconi marine wireless telegraph apparatus, comprising 2-kilowatt transmitters for long, medium and short wavelengths, and receivers covering the whole commercial waverange, with additional units for strengthening weak signals and reducing interference. To assist the navigators, the Marconi Direction Finder with the fixed frame aerial is installed, the direction finding instrument being fitted in the wireless cabin. The liners carry all other safety wireless apparatus, including an emergency set working from an independent source of power, and lifeboat sets.

The "Corfu" and "Carthage" are supplied with a special type of Marconi Band Repeater consisting of a cabinet containing a double turn-table for gramophone records, an amplifier and a motor generator. Two deck loud speakers are supplied for use when and where they are required, and two other loud speakers, mounted in polished wooden cabinets, are for internal use in the ship. All the loud speakers are fitted with flexible cable and sockets, and have local volume control units to enable them to be switched on or off and the volume to be regulated to suit local requirements.

Marconi Sounding Device.

IN addition to this wireless equipment the "Strathnaver" and the "Strathaird" are fitted with the latest type of Marconi Sounding Device—the Echometer, built on the famous Langevin-Chilowsky system—which gives instantaneously, and without the use of the ship's dynamo, the depth of water immediately under the ship.

This instrument is silent in operation and can be switched on by the Officer on watch and left running as long as it is required without causing any disturbance to the passengers or crew.

This silent operation is unique among sounding devices, and is due to the fact that the waves transmitted through the water are produced by a small transmitter at supersonic frequency. They are imparted to the water by the projector, which consists of a quartz crystal between two thick steel plates, in the bottom of the ship. The outer of these plates, being made to vibrate by the action of the electrical charge on the crystal, imparts a wave motion to the water, directed towards the sea bed. The only power required for this operation is a 4-volt accumulator. There is no hammer, electric motor or other running machinery, and the same small hull fitting acts as both transmitter and receiver.

A ship's officer "taking soundings" with the Marconi Echometer.

Continuous soundings can be taken, with many readings a minute, and navigators have appreciated the value of operating this device simultaneously with the wireless direction finder. The result is an absolutely correct check of the ship's position, giving true compass bearings from one or more points of land and the depth of water and the consistency of the sea bed under the ship.